

WHAT IS CLAIMED IS:

1. A tube connecting apparatus having a first holding assembly and a second holding assembly which hold at least two flexible tubes approximately in a parallel state, comprising:

a first pressing unit which is provided at the first holding assembly and which presses the tubes to a flat state;

a second pressing unit which is provided at the second holding assembly and which presses the tubes to a flat state;

a third pressing unit which is disposed between the first and second pressing units and which presses the tubes to a flat state;

a cutting unit which cuts the tubes between the first and second pressing units; and

a movement unit which moves at least one of the first and second holding assemblies to change relatively positions of the tubes cut by the cutting unit such that end portions to be connected contact closely each other.

2. A tube connecting apparatus according to claim 1, wherein the third pressing unit is disposed movably to and integrally with either one of the first holding assembly and the second holding assembly.

3. A tube connecting apparatus according to claim 1, wherein the movement unit has a first movement unit which moves the first holding assembly in a first direction which is a width direction of the tubes and a second movement unit which moves the second holding assembly in a second direction which is a length direction of the tubes and which is a direction orthogonal to the first direction.

4. A tube connecting apparatus according to claim 1, wherein the third pressing unit has an energizing section which energizes the tubes to a pressing position at which the tubes are pressed to a flat state and a stopping section which regulates energizing force of the energizing section to stop movement of the third pressing unit.

5. A tube connecting apparatus according to claim 4, wherein the stopping section has a first stopping member for stopping movement of the third pressing unit in a direction of pushing the tubes further from the pressing position and a second stopping member for stopping movement of the third pressing unit to locate the third pressing unit at an evacuating position which is separated from the pressing position so as to allow the cutting unit to cut the tubes.

6. A tube connecting apparatus according to claim 5, wherein the first stopping member comprises a stepped portion which engages the third pressing unit and which is formed at a part of either one of the first and second pressing units which is disposed adjacent to the third pressing unit, and the second stopping member has a lever member for moving the third pressing unit so as to engage and hold the third pressing unit at the evacuating position and an actuator for actuating the lever member movably.

7. A tube connecting apparatus according to claim 6, wherein the cutting unit has a cutting plate for melting and cutting the tubes in a heated state, a cutting-plate holding section for holding the cutting plate and a cutting-plate movement section for moving the cutting-plate holding section, and wherein, when the cutting-plate holding section is moved by the cutting-plate movement section, the third pressing unit is moved to the evacuating position while resisting the energizing force of the energizing section in a state that a first projection member formed at a part of the cutting-plate holding section engages a second projection member formed at a part of the third pressing unit.

8. A tube connecting apparatus according to claim 1, further comprising an evacuation unit which evacuates the third pressing unit to an evacuating position which is separated from a pressing position at which the tubes are pressed to a flat state, and wherein the cutting unit cuts the tubes between the first and second pressing units in a state that the third pressing unit is evacuated to the

evacuating position by the evacuation unit.

9. A tube connecting apparatus according to claim 8, wherein the movement unit has a first movement unit which moves the first holding assembly in a first direction which is a width direction of the tubes and a second movement unit which moves the second holding assembly in a second direction which is a length direction of the tubes and which is a direction orthogonal to the first direction, wherein the first movement unit moves the first holding assembly in the first direction to change relatively positions of the tubes cut by the cutting unit such that end portions of the tubes to be connected face each other and the second movement unit moves the second holding assembly in the second direction such that the end portions of the tubes to be connected contact closely each other, and wherein a distance between the first pressing unit provided at the first holding assembly which is movable in the first direction and the cutting unit is set to be larger than a distance between the second pressing unit provided at the second holding assembly which is movable in the second direction and the cutting unit.

10. A tube connecting apparatus according to claim 9, wherein a moving distance of the first holding assembly in the first direction is set to be larger than a moving distance of the second holding assembly in the second direction.

11. A tube connecting apparatus according to claim 1, wherein the first pressing unit has a first pressing section for pressing the tubes to a flat state and a first supporting section for supporting the tubes which are pressed by the first pressing section, the second pressing unit has a second pressing section for pressing the tubes to a flat state and a second supporting section for supporting the tubes which are pressed by the second pressing section, and further comprising:

an evacuation guiding unit which guides the third pressing unit in a direction of an evacuating position when the cutting unit cuts the tubes; and

a stopping unit which is provided at the first or second pressing unit and which stops the third pressing unit to locate the third pressing unit at the evacuating position.

12. A tube connecting apparatus according to claim 11, further comprising an energizing unit which is disposed adjacent to the stopping unit and which energizes the stopping unit in a direction of the third pressing unit.

13. A tube connecting apparatus according to claim 11, wherein a groove portion is formed at a part of the third pressing unit, and wherein, when the third pressing unit is guided to the evacuating position by the evacuation guiding unit, the stopping unit engages the groove portion to stop the third pressing unit at the evacuating position.

14. A tube connecting apparatus according to claim 11, wherein the cutting unit has a cutting plate for melting and cutting the tubes in a heated state, a cutting-plate holding section for holding the cutting plate and a cutting-plate movement section for moving the cutting-plate holding section, and wherein the evacuation guiding unit is connected or integrally formed with the cutting-plate holding section.

15. A tube connecting apparatus according to claim 11, further comprising a cancellation unit which is provided at the first or second supporting unit and which cancels a stopping state of the third pressing unit according to the stopping unit.

16. A tube connecting apparatus according to claim 15, wherein the cancellation unit cancels the stopping state of the third pressing unit according to the stopping unit linking with separating movement of the first or second pressing unit from a side of the first or second supporting unit.

17. A tube connecting apparatus according to claim 16, wherein

the stopping unit has an inclined face at a part thereof and the cancellation unit has a rotatable roller member, and wherein the stopping state of the third pressing unit is canceled in a manner that the stopping unit leaves the groove portion of the third pressing unit due to that the stopping unit is pushed along the inclined face by the roller member.

18. A tube connecting apparatus according to claim 11, wherein one of the first or second pressing unit has a projection portion projecting toward another of the first or second pressing unit and the another of the first or second pressing unit has a groove portion or a dented portion into which the projection portion is inserted, and wherein the groove portion or the dented portion has a shape which allows the projection portion to move when the first or second holding assembly is moved by the movement unit.

19. A tube connecting method for cutting and then connecting at least two flexible tubes, comprising the steps of:

pressing the tubes put approximately in a parallel state at a first position to deform the tubes to a flat state;

pressing the tubes at a second position adjacent to the first position to hold the tubes in a flat state;

pressing the tubes at a third position which is adjacent to the first position and which is a position opposing to the second position via the first position to hold the tubes in a flat state;

advancing a heated cutting plate between the second and third positions to cut the tubes;

moving relatively the tubes which have been cut to face end portions of the tubes to be connected each other; and

evacuating the cutting plate from a predetermined cutting position located between the second and third positions to contact the end portions of the tubes closely each other for connecting the tubes.

20. A tube connecting method according to claim 19, wherein, in the step of cutting the tubes, the cutting plate advances to the

cutting position linking with cancellation of pressing to the tubes at the first position.

21. A tube connecting method according to claim 20, wherein, when the tubes which have been cut are moved relatively, the tubes are moved along at least one face side of the cutting plate in a state that the cutting plate is kept located at the cutting position.